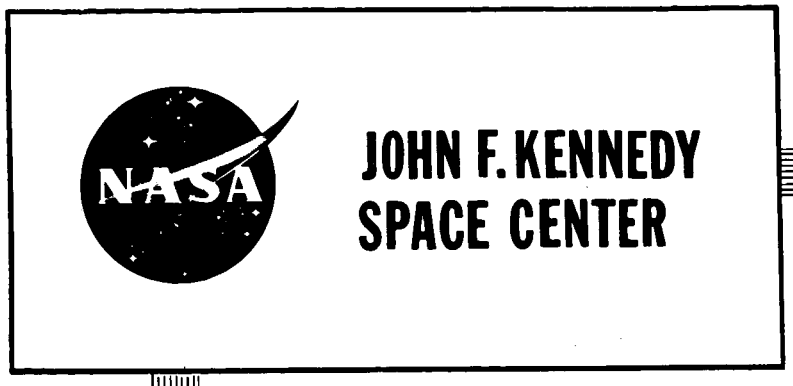

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A SELECTIVE BIBLIOGRAPHY

INTRODUCTION

This bibliography on fuel cells for space applications lists only materials available in the Kennedy Space Center Library.

The bibliography is arranged chronologically under three headings; Documents, Periodicals, and Books, and then alphabetically by title. The first section consists of documents published between January 1964 and June 1966. Only final reports or latest available interim reports have been cited. The second section lists periodical articles published during the same period. The third section includes all books, regardless of publication date, which contain one or more chapters pertaining to fuel cells.

Citations available on microfiche have been indicated by underlining the accession series number, e.g., N66-99985, A66-63241 or X66-13039. All other items are available in hard copy. The classification number for the KSC Library books has been included as a location aid for the user. "Ref." at the beginning of the classification number indicates that a reference copy is available. Periodical citations are listed with the name of the periodical, date, volume number, and page number. For example:

Journal	Date	Volume	Pages
Chemical Engineering,	6 Jan. 1964,	71:	32-34.

It would be remiss of me not to thank my LTV colleagues for their assistance in the preparation of this work, but the responsibility for any errors must be mine alone.

Ruth E. Perks
Assistant to the Librarian, Reference

DOCUMENTS

1964

BIOCHEMICAL FUEL CELLS. Fourth Quarterly Report, 1 February - 30 April 1964. G. E. Ellis and E. E. Sweeney, 1964, 35 p., diagrs. (NASA-CR-56231; QR-25136; Rept. -4; N64-25769). Marquardt Corp., Van Nuys, Calif.

"Biochemical fuel cells for degrading human waste and producing electrical energy." (Doc. Inc.)*

CEROLYTE FUEL CELLS. D. H. Archer et al., 1964, 58 p., illus., diagrs. (QTPR-2; N64-33526). Westinghouse Electric Corp., Pittsburgh, Pa.

"Measurements of polarization voltage losses and design of cerolyte fuel cell battery." (Doc. Inc.)

CONFERENCE ON NEW TECHNOLOGY. (Conference held at Lewis Research Center, Cleveland, O., June 4-5, 1964) 1964, 161 p., illus., diagrs. (NASA-SP-5015; N64-32767). National Aeronautics and Space Administration, Lewis Research Center, Cleveland, O.

Fuel cell fundamentals and state-of-the-art for space applications are discussed in a paper on electric power generation.

THE DERIVATION OF AN ELECTRICAL EQUIVALENT CIRCUIT FOR A FUEL CELL SYSTEM, JANUARY - NOVEMBER, 1964. R. M. McKechnie III, Jul. 1965, 65 p., diagrs. (Rept. -1816; X66-11928). Army Engineer Research and Development Labs., Fort Belvoir, Va.
"Available to U.S. Government agencies and their contractors only."

"The analytical development, test procedure and equipment, and the digital computer program for equivalent circuit data analysis are presented in detail." (Author)

DEVELOPMENT AND TESTING OF ELECTROLYTE MATRIX COMBINATIONS FOR MERCURY-POTASSIUM FUEL CELL. Final Report. W. S. Colwell et al., Jan. 1964, 132 p., illus., diagrs. (NASA-CR-53108; EDR-3709; N64-16747). General Motors Corp., Allison Division, Indianapolis, Ind.

"Electrolyte matrix for liquid potassium-mercury fuel cell." (Doc. Inc.)

* Documentation Incorporated, College Park, Md.

DEVELOPMENT OF THE DUAL MEMBRANE FUEL CELL AND THE OSMOTIC STILL, Final Report, 30 June 1962 - 15 December 1963. May 1964, 227 p., illus., diagrs., (NASA-CR-43; N64-21252). Thompson Ramo Wooldridge, Inc., Cleveland, O.

"Optimum materials for dual membrane fuel cell material-evaluation of ion exchange membranes for osmotic water purification still." (Doc. Inc.)

DIRECT AMMONIA-AIR FUEL CELL. Quarterly Report No. 3, 1 January - 1 April 1964. 1964, 50 p., diagrs., (Rept. -3; N64-29585). Electrochimica Corp., Research and Development Lab., Menlo Park, Calif.

"Matrix-type direct ammonia-air fuel cell operating at intermediate temperatures." (Doc. Inc.)

DISCUSSION AND WEIGHT PREDICTION OF REGENERATIVE FUEL CELL SYSTEMS, Volume II. J.H. Thielman 1964, 34 p., diagrs., (D2-22311-1, vol. II; N65-15132). Boeing Co., Seattle, Wash.

"Regenerative fuel cell weight determination from component weight factor and space flight power requirements." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. Hydrogen Evolution at a Dropping Indium Amalgam Electrode. J.N. Butler and A.C. Makrides, Feb. 1964, 28 p., diagrs., (TM-10; N64-22119). Tyco Labs., Inc., Waltham, Mass.

"Electrochemistry of fuel cell electrodes - hydrogen evolution at dropping indium amalgam electrode." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES, Hydrogen Evolution at a Solid Indium Electrode. J.N. Butler and M.D. Dienst, Apr. 1964, 43 p., diagrs., (TH-11; N64-27623). Tyco Labs., Inc., Waltham, Mass.

"Electrochemistry of fuel cell electrodes - hydrogen evolution at solid indium electrode." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. Technical Memorandum. Aug. 1964, 36 p., diagrs., (TM-14; N65-10643). Tyco Labs., Inc., Waltham, Mass.

"Electrochemistry of fuel cell electrodes - carbon monoxide and formic acid studies." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. The Electrical Double Layer on Indium Amalgams in 0.1 M $HClO_4$ at 25°C. J.N. Butler, et al., Sept. 1964, 46 p., diagrs., (TM-15; N65-12066). Tyco Labs, Inc., Waltham, Mass.

"Electrical double layer capacity of indium amalgam in hydroperchloric acid - fuel cell electrodes." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. The Electrical Double Layer on Thallium Amalgam Electrodes. J.N. Butler, Oct. 1964, 30 p., diagrs., (TM-16; N65-14409). Tyco Labs., Inc., Waltham, Mass.

"Electrochemistry of thallium amalgam fuel cell electrodes." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELLS ELECTRODES. The Use of Large Anodic Galvanostatic Transients to Elevate the Maximum Adsorption on pt from HCOOH Solutions. S.B. Brummer, Aug. 1964, 40 p., diagrs., (TM-13; N65-13969). Tyco Labs., Inc., Waltham, Mass.

"Adsorption on platinum in fuel cells evaluated by large anodic galvanostatic transients." (Doc. Inc.)

ENGINEERING STUDY OF MULTIPURPOSE ENGINE AND FUEL SYSTEM FOR MANNED LUNAR BASES, Volume 1 -- SUMMARY AND CONCLUSIONS. Interim Report. 13 Jan. 1964, 31 p., diagrs., (NASA-CR-56140; WANL-PR/S/-004-8 X64-14165). Westinghouse Electric Corp., Astronuclear Lab., Pittsburgh, Pa. "Available to U.S. Government agencies only."

Hydrogen-oxygen fuel cell employed as multipurpose fuel system in APOLLO lunar exploration bases." (Doc. Inc.)

EVALUATION PROGRAM FOR NICKEL CADMIUM SEALED CELLS. General Performance Test of General Electric Company 3.0 Ampere Hour Cells. E.C. Bruess, 6 Jan. 1964, 40 p., diagrs., (NASA-CR 055630; QE/C-64-1; N64-16104). Naval Ammunition Depot, Quality Evaluation Lab., Crane, Ind.

"Performance test of nickel-cadmium sealed fuel cells." (Doc. Inc.)

EXTENDED APOLLO SYSTEMS UTILIZATION STUDY FINAL REPORT. Vol. 8 - Alternate Power Source. 16 Nov. 1964, 106 p., illus., diagrs., (NAA-SID-64-1860-8). North American Aviation, Space and Information Systems Division.

Reports on investigations of GEMINI fuell cell adaptability to meet the APOLLO X mission requirements.

FEASIBILITY STUDIES OF THE ELECTROTHERMALLY REGENERATIVE TRANSDUCER. Final Report, Part II. R.D. Weaver, 30 June 1964, 91 p., illus., diagrs., (N65-13335). General Motors Corp., Delco-Remy Div., Anderson, Ind.

"Electrothermally regenerative transducer and fuel cell battery based on alkali metals and halogens as reactants." (Doc. Inc.)

FUEL CELL MEMBRANE ELECTRODE CONFIGURATION. M.C. Deibert, 31 Aug. 1964, 24 p., diagrs., (MRB-4020T1; N64-33316). Monsanto Research Corp., Boston Labs, Everett, Mass.

"Fuel cell membrane electrode testing for activity as anodes for oxidation of hydrogen, propane, hydrazine, methanol and for reduction of oxygen." (Doc. Inc.)

FUEL CELL POWER SYSTEMS FOR MOLAB. C.O. De Long and E.E. Dungan, 16 Mar. 1964, 29 p., (NASA -TM-X-57133; X66-13039). National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
"Available to U.S. Government agencies and their contractors only."

Static vapor pressure control for fuel cell power system in lunar mobile laboratory." (Doc. Inc.)

FUEL CELL REACTANT PROPERTIES. (Presented at 6th AGARD combust. and propulsion colloq., Cannes, France, 16-20 Mar. 1964) R.G.H. Watson, 1964, 35 p., (N65-18238). Admiralty Materials Lab., Poole, England.

"Fuel cell reactant properties - fuel, oxidant, electrodes, and electrolyte." (Doc. Inc.)

FUEL CELLS. Quarterly Progress Report, 1 January - 31 March 1964. R.D. Walker, Jr., 24 Jun. 1964, 43 p., (UFCG-11; X64-16802).
"Available to U.S. Government agencies and their contractors only."

"Oxygen solubilities and diffusivities in fuel cell electrolytes, mass transfer in porous gas diffusion electrodes and hydrogen diffusion through palladium foils." (Doc. Inc.)

FUEL CELLS. Selected References. Lois J. Stout, Nov. 1964, 101 p., (Bibliographic List No. 2; N65-20760). Federal Aviation Agency, Aeronautical Center, Library Branch, Oklahoma City, Okla.

A selected list of references providing information on research in fuel cells from 1953 through March 1964.

5 KW HYDROCARBON-AIR FUEL CELL SYSTEM. Semiannual Technical Summary Report, 1 February - 11 June 1964. M.L. Engle, 30 Jun. 1964, 32 p., (N65-15702). Allis-Chalmers Mfg. Co., Space and Defense Sciences Dept., Milwaukee, Wis.

"Hydrocarbon-air fuel cell." (Doc. Inc.)

HYDROGEN GENERATION FOR FUEL CELLS. Final Report, 1 May 1962 - 30 September 1964. E.J. Emerson et al, 1964, 85 p., illus., diagrs., (Rept. -8; X65-16226). Engelhard Industries, Inc., Process Equipment Div., East Newark, N.J.
"Available to U.S. Government agencies and their contractors only."

"Small portable hydrogen generators for fuel cells." (Doc. Inc.)

HYDROGEN-OXYGEN ELECTRODE STUDY. Quarterly Progress Report No. 9. T.J. Gray et al., 15 Mar. 1964, 11 p., diagrs., (N64-21398). Alfred Univ., N.Y.

"Electrochemical study of catalytic activity on hydrogen electrode in fuel cell." (Doc. Inc.)

HYDROGEN-OXYGEN PROTOTYPE FUEL CELL. Final Engineering Report, Period Ending March 31, 1964. G.R. Drengler, 1964, 73 p., diagrs., (X65-17560). Union Carbide Corp., Development Dept., Parma, O.
"Available to U.S. Government agencies and their contractors only."

"Design and testing of hydrogen-oxygen prototype fuel cell for use in submarine propulsion." (Doc. Inc.)

INVESTIGATION OF THE FUNDAMENTAL ELECTROCHEMICAL PARAMETERS INFLUENCING FUEL CELL PERFORMANCE. Final Report. N.D. Greene, 15 Sept. 1964, 7 p., (AFCRL-64-793; N65-18977). Rensselaer Polytechnic Inst., Troy, N.Y.

"Fuel cell characteristics prediction from polarization curves of electrodes." (Doc. Inc.)

INVESTIGATION OF THE HYDROGEN-OXYGEN FUEL CELL II. H.F. Hunger and W.G. Taschek, Jul. 1964, 26 p., illus., diagrs., (AEL-TR-2491; N65-11814). Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.

"Electrochemical oxidation in hydrogen-oxygen fuel cell." (Doc. Inc.)

INVESTIGATION OF ZEOLITE MEMBRANE ELECTROLYTES FOR FUEL CELLS. Final Report. F.C. Arrance et al., Mar. 1964, 155 p., illus., diagrs., (NASA-CR-54023; Rept. -108F; N64-23947). Douglas Aircraft Co., Inc., Newport Beach Calif.

"Zeolite membrane electrolytes for fuel cells." (Doc. Inc.)

KINETIC FACTORS IN FUEL CELL SYSTEMS. The Oxygen Electrode. (Presented at the 6th AGARD combust. and propulsion colloq., Cannes, France, Mar. 16-20, 1964.) A. Kozawa and E. Yeager, 1964, 33 p., diagrs., (N65-18237). Western Reserve Univ., Cleveland, O.

"Kinetic factors in oxygen electrode fuel cell systems." (Doc. Inc.)

LUNAR MOBILE LABORATORY POWER SYSTEM ANALYSIS. D.V. Merrifield. 16 Jun 1964., 55 p., diagrs., (NASA-TM-X-51864; TR-63-2-D; X64-15595). National Aeronautics and Space Administration, John F. Kennedy Space Center, Cocoa Beach, Fla.
"Available to U.S. Government agencies and their contractors only."

"Analysis of hydrogen-oxygen fuel cell power system of lunar mobile laboratory." (Doc. Inc.)

MATERIALS OF CONSTRUCTION FOR HYDROCARBON-AIR FUEL CELLS WITH HOT CONCENTRATED PHOSPHORIC ACID ELECTROLYTE. Interim Report. No. 1. A. Kuchar and P.V. Popat, 1 Apr. 1964, 31 p., diagrs., (N64-21297). General Electric Co., Lynn, Mass.

"Electrochemical corrosion of metals and alloys in phosphoric acid electrolyte of hydrocarbon-air fuel cells." (Doc. Inc.)

METHOD OF COMPUTING THE SPECIFIC CAPACITY OF FUEL CELLS/METODY RASCHETA UDELNOY TOPLIVNYKH ELEMENTOV. (Translated into English from Inzh. -Fiz. ZH./USSR, v. 6, 1963, p. 86,87.) V. S. Daniel-Bek, Aug. 1964, 4 p., diagrs., (NASA-TT-F-9039; N64-27328). National Aeronautics and Space Administration, Washington, D. C.

"Computation of specific energy of fuel cells activity." (Doc. Inc.)

MOLTEN-CARBONATE FUEL BATTERY PROGRAM, TASK I, Final Technical Report, 15 February 1963 - 15 February 1964. 31 Aug. 1964, 165 p., illus., diagrs., (TI-08-64-114; N65-14089). Texas Instruments, Inc., Dallas.

"Molten carbonate hydrocarbon air fuel cell." (Doc. Inc.)

PHENOMENA AT A GAS-ELECTRODE-ELECTROLYTE INTERFACE. D.N. Bennion, 1 Jun.1964, 150 p., diagrs., (TR-3; N65-12539). Univ. of California, Berkeley.

"Electrode-electrolyte gas interface in fuel cells." (Doc. Inc.)

A POSSIBLE REGENERATIVE, MOLTEN-SALT THERMOELECTRIC FUEL CELL. J. Greenbert et al., Aug. 1964, 9 p., diagrs., (NASA-TN-D-2440; N64-27361). National Aeronautics and Space Administration, Lewis Research Center, Cleveland, O.

"Molten or fused salts evaluated as thermoelectric material for regenerative fuel cell." (Doc. Inc.)

RADIOACTIVE ISOTOPE FUELED THERMOELECTRIC GENERATORS FOR SPACE MISSIONS. E. De Haas, 1964, 178 p., illus., diagrs., (N66-17621). Radio Corp. of America, Princeton, N.J.

"Radioactive isotope fueled thermoelectric power generator for space missions." (Doc. Inc.)

RESEARCH AND DEVELOPMENT OF AN ADVANCED LABORATORY LIQUID METAL REGENERATIVE FUEL CELL. J.D. Mangus, Apr. 1964, 156 p., illus., diagrs., (EDR-3740; APL-TDR-64-41; N64-20167). General Motors Corp., Allison Div., Indianapolis, Ind.

"Liquid magnesium regenerative fuel cell." (Doc. Inc.)

RESEARCH AND DEVELOPMENT OF HIGH PERFORMANCE LIGHTWEIGHT FUEL CELL ELECTRODES. Third Quarterly Report, May 1 - July 31, 1964. W.P. Colman et al., 15 Sep. 1964, 107 p., illus., diagrs., (NASA-CR-54171; N64-31456). American Cyanamid Co., Research Labs., Stamford, Conn.

"High performance lightweight fuel cell electrode development-analysis of electrolyte concentration and temperature gradients." (Doc. Inc.)

RESEARCH AND DEVELOPMENT OF AN OPEN-CYCLE FUEL CELL SYSTEM. Summary Report, 1 January - 31 August 1964. R. Desai et al., 30 Sep. 1964, 121 p., illus., diagrs., (NASA-CR-59894; N65-13222). Allis-Chalmers Mfg. Co., Research Div., Milwaukee, Wis.

"Theory, operation, and testing of components, single and multicell assemblies, static moisture removal subsystem and mathematical model of hydrogen-oxygen membrane fuel cell system." (Doc. Inc.)

RESEARCH IN THE CONVERSION OF VARIOUS FORMS OF ENERGY BY UNCONVENTIONAL TECHNIQUES. Status Report, June 1964. J.O. Bockris, 10 Aug. 1964, 29 p., diagrs., (NASA-CR-58809; N64-30521). Pennsylvania Univ., Towne School of Civil and Mechanical Engineering, Philadelphia.

"Methods for energy conversion in biochemical fuel cells, plasma physics, and thermal energy storage." (Doc. Inc.)

RESEARCH RELATING TO FUEL CELLS - PALLADIUM ELECTRODES. Final and Summary Report, 1 October 1962 - 30 June 1964. A.C. Makrides, 31 Jul. 1964., 110 p., diagrs., (N65-10793). Tyco Labs., Inc., Waltham, Mass.

"Solid state hydrogen diffusion electrodes for fuel cell systems." (Doc. Inc.)

RESEARCH TO IMPROVE ELECTROCHEMICAL CATALYSTS. Final Technical Report, 15 May 1963 - 15 May 1964. R. M. Kliss et al., 27 Jul. 1964, 74 p., diagrs., (X64-16450; N64-33983). Monsanto Research Corp., Boston Lab., Everett, Mass.

"Metal chelate catalysts for electrochemical oxidation of organic fuel in fuel cell." (Doc. Inc.)

REVERSIBLE OXYGEN ELECTRODES. Report No. 12 and Final Report, November 1961 - 31 December 1964. 31 Dec. 1964, 34 p., diagrs., U.S. Army Electronics Laboratories, Fort Monmouth, New Jersey, and Univ. of Pennsylvania, Electrochemistry Laboratory, Philadelphia, Pa.

Summarizes the purpose, experimental approaches and findings of the research on reversible oxygen electrodes. Possible methods for oxygen reduction are discussed for both acid and alkaline media.

THE SIMPLE-PORE AND THIN-FILM MODELS OF POROUS GAS DIFFUSION ELECTRODES. M. Ariet et al., May 1964, 36 p., diagrs., (Rept. -7; N64-26931). Pennsylvania State Univ. College of Mineral Industries, University Park, Md.

"Two physical models for operation of porous gas diffusion electrodes in fuel cells - simple pore model and thin film model." (Doc. Inc.)

STATUS REPORT AS OF JANUARY, 1964. 28 Feb. 1964, 106 p., illus., diagrs., (NASA-CR-53557; N64-18304). Pennsylvania Univ., Philadelphia.

"Biochemical fuel cells, plasma physics - MHD and thermionics, thermal energy storage, thermal transport and solar reflector research." (Doc. Inc.)

STUDY OF BIOCHEMICAL FUEL CELLS. Final Report, 19 March 1963 - 19 September 1964. G.E. Ellis, 1964, 123 p., illus., diagrs., (Marquardt Corp. Report 25144; NASA-CR-60978; N65-17952). Marquardt Corp., Van Nuys, Calif.

"Human waste for biological fuel cells." (Doc. Inc.)

STUDY OF FUEL CELLS USING STORABLE ROCKET PROPELLANTS, Final Report, 28 June 1963 - 27 January 1964. R.E. Chute et al., 11 May 1964, 160 p., illus., diagrs., (NASA-CR-54116; MRB-5002F; N64-25901). Monsanto Research Corp., Boston Lab., Everett, Mass.

"Fuel cells using storable rocket propellants." (Doc. Inc.)

STUDY OF THE FUNDAMENTAL PRINCIPLES OF BIOELECTROCHEMISTRY. Final Technical Report March 1963 - March 1964. P.R. Basford et al., 30 June 1964, 111 p., diagrs., (NASA-CR-54051; U-2670; N64-25906). Aeronutronic, Research Labs, Newport Beach, Calif.

"Biochemical fuel cell for electrochemical energy production." (Doc. Inc.)

STUDY PROGRAM TO IMPROVE FUEL CELL PERFORMANCE BY PULSING TECHNIQUES. Final Report. K.V. Kordesch and M.L. Kronenberg, 28 Jun. 1964, 47 p., illus., diagrs., (NASA-CR-54150; N64-28086). Union Carbide Corp., Parma Research Lab, Parma, O.

"Improving fuel cell performance by pulsing techniques." (Doc. Inc.)

THERMALLY REGENERATIVE FUEL CELLS. (Presented at the 6th AGARD combustion and propulsion colloq., Cannes, France, March 16-20, 1964) R.E. Henderson, 1964, 15 p., illus., diagrs. (N65-16156). General Motors Corp., Allison Div., Indianapolis, Ind.

"Thermomechanical and electrothermal separation methods for thermally regenerative fuel cells." (Doc. Inc.)

THERMAL VACUUM TEST OF ORBITAL STATIC MOISTURE REMOVAL FUEL CELL. Technical Documentary Report, March 16-20, 1964. L.S. Harootyan, Jul. 1964, 21 p., illus., diagrs., (APL-TDR-64-72; N64-30921). Air Force Systems Command, Aero Propulsion Lab, Wright-Patterson AFB, O.

"Thermal vacuum test of orbital static moisture-removal fuel cell." (Doc. Inc.)

THIN FUEL CELL ELECTRODES, Final Report, 1 June 1963 - 31 May 1964. M. B. Clark et al., 1964, 78 p., illus., diagrs., (Rept. -4; N65-35721). Union Carbide Corp., Parma Research Center, Parma, O.

"Thin lightweight gas diffusion electrodes for fuel cells." (Doc. Inc.)

1965

AES PRELIMINARY DEFINITION PHASE APOLLO EXTENSION SYSTEM FINAL REPORT. Power Generation and Distribution Systems. 13 Dec. 1965, 332 p., diagrs., (NAA-SID-65-1525). North American Aviation, Inc., Space and Information Systems Division.

"Describes the analysis and results of studies of APOLLO Block II fuel cells and modifications." (Author)

ALSS PAYLOAD. Volume II, Book 6 - Power Systems, Part I Sections 1 to 4 and Appendix A. Final Report. Jun. 1965, 120 p., illus., diagrs., (NASA-CR-64671; ALSS-TR-013, vol. II, Bk. 6; X65-19301). Bendix Corp., Bendix Systems Div., Ann Arbor, Mich.
"Available to U.S. Government agencies and their contractors only."

"Electrical power systems and thermal control for MOLAB missions." (Doc. Inc.)

ALTERNATE APPROACHES TO STERILIZABLE POWER SOURCES. D.G. Soltis, 1965, 13 p., (NASA-TM-X-52137; N66-14763). National Aeronautics and Space Administration, Lewis Research Center, Cleveland, O.

"Development of batteries that can be sterilized and operated after high temperature storage - silver-zinc battery and electrically regenerative hydrogen-oxygen fuel cell." (Doc. Inc.)

AMMONIA-AIR FUEL CELL SYSTEM FOR VEHICLE PROPULSION. Final Technical Report, 27 July 1964 - 27 July 1965. A. Levy, 27 Jul. 1965, 107 p., diagrs., (PWA-2636; X66-11599). Pratt and Whitney Aircraft, East Hartford, Conn.
"Available to U.S. Government agencies only."

"Ammonia-air fuel cell system for vehicle propulsion - electric power conversion." (Doc. Inc.)

AMMONIA PRODUCTION FEASIBILITY STUDY. Final Technical Report, November 1964 - November 1965. R.M. Reinstrom et al., Nov. 1965, 358 p., illus., diagrs., (EDR-4200; X66-14563). General Motors Corp., Allison Div., Indianapolis, Ind.
"Available to U.S. Government agencies only."

"Hydrogen and nitrogen production processes in feasibility study of ammonia fuel production." (Doc. Inc.)

BEHAVIOR OF THE CARBON ELECTRODE IN MOLTEN CARBONATES. M.D. Ingram and G.J. Janz. Nov. 1965, 13 p., diagrs., (TR-27; N66-16467). Rensselaer Polytechnic Inst., Dept. of Chemistry, Troy, N.Y.

"Reversability of various carbons as electrodes in ternary carbonate eutectic - simulation and use of electrodeposited carbon in high temperature fuel cell." (Doc. Inc.)

BIBLIOGRAPHY OF FUEL CELL CONTRACTS. H. Lerner et al., Jan. 1965, 28 p., (MIES Rept. 8). Pennsylvania State University, Philadelphia.

A list of 220 contracts for fuel cell work sponsored by 34 Federal agencies to 97 prime contractors from 1954 to 1964.

BIOCHEMICAL FUEL CELLS. J.A. Christopulos and J. Perry, Jr., Aug. 1965, 25 p., diagrs., (ECOM-2616; N66-12114). Army Electronics Labs., Fort Monmouth, N.J.

"Ethanol-air biochemical fuel cell feasibility test." (Doc. Inc.)

BIOCHEMICAL FUEL CELLS. (Annual Power Sources Conference, 19th, Atlantic City, N.J., May 18-20, 1965) J. Christopulos and J. Perry, Jr., 5 p., diagrs., (A66-15306). Army Electronics Labs., Fort Monmouth, N.J.

"Biochemical processes used to produce fuels for fuel-cell batteries, including fermentation processes involving microorganisms acting on carbohydrates." (Doc. Inc.)

BIOCHEMICAL FUEL CELL, Final Report, 1 July 1962 - 30 June 1965. G.C. Blanchard and C.R. Goucher, 1965, 109 p., illus., diagrs., (Rept.-12; N66-13715). Melpar, Inc., Falls Church, Va.

"Hydrogen production by microorganisms for use in biochemical hydrogen-oxygen fuel cell." (Doc. Inc.)

BIOCHEMICAL FUEL CELLS. Final Report, 1 July 1962 - 31 March 1965. J.M. Brake, 1965, 190 p., illus., diagrs., (STL-4399-6001-RU-000; N65-34166). Magna Corp., Anaheim, Calif.

"Biochemical fuel cells - electrochemical studies and formic acid production process." (Doc. Inc.)

CAPILLARY FUEL CELL ORBITAL EXPERIMENT. (American Society of Mechanical Engineers, Aviation and Space Conference, Los Angeles, Calif., Mar. 14-18, 1965) R. J. Chesner and J.C. Prestidge, p. 30-33, diagrs., (ASME Paper 65-AV-28; A65-25022).

"Capillary hydrogen-oxygen fuel cell system development and design for performance in space environment." (Doc. Inc.)

DESIGN, DEVELOPMENT, AND EVALUATION OF A CRASH-RESISTANT FUEL SYSTEM INSTALLATION. W. Buckson et al., Dec. 1965, 110 p., illus., diagrs., (FAA-ADS-27; N66-26072). All American Engineering Co., Wilmington, Del.

"Crash resistant fuel system for civil aircraft." (Doc. Inc.)

DESIGN OF HYDROGEN-OXYGEN CAPILLARY TYPE FUEL CELL. Final Technical Report, 1 November 1963 - 31 January 1965. D.R. Bruesewitz et al., Jan. 1965, 126 p., illus., diagrs., (AFAPL-TR-64-155; N65-17907). Allis-Chalmers Mfg. Co., Space and Defense Sciences Dept., Milwaukee, Wis.

"Capillary fuel cell use as energy source for space missions." (Doc. Inc.)

DEVELOPMENT OF IMPROVED ELECTRODES FOR FUEL CELLS. Final Report, 17 May 1964 - 17 May 1965. R.A. Botosan et al., May 1965, 220 p., illus., diagrs., (LMSC-4-45-65-2; X66-12918). Lockheed Missiles and Space Co., Sunnyvale, Calif.
"Available to U.S. Government agencies and their contractors only."

"Methods for improving fuel cell electrodes for hydrazine-oxygen and hydrogen-oxygen systems." (Doc. Inc.)

DEVELOPMENT OF IMPROVED ELECTRODES FOR FUEL CELLS. Quarterly Report No. 3, 17 Nov. 1964 - 17 Feb. 1965. S.J. Szpak and T. Katan. Nov. 1965, 45 p., diagrs., (LMSC-4-45-65-1). Lockheed Missiles and Space Co., Palo Alto, Calif.

Hydrazine and oxygen electrode experiments are presented. The report concludes that hydrogen oxidation should be very thin with the catalyst on the frontal surface of the porous electrode and that a co-current flow of electrolyte is mandatory.

DEVELOPMENT OF THE MOLTEN CARBONATE FUEL CELL SYSTEM. (Symposium on Fuel Cell Systems and Processes, Part II, American Institute of Chemical Engineers, Annual Meeting, 58th, Philadelphia, Pa., Dec. 5-9, 1965) F. L. Gray and J. K. Truitt, Preprint 20D, 10 p., illus., diagrs. (A66-21187).

"Molten carbonate fuel cell module featuring flexibility of construction, electrical simplicity and effective gas distribution characteristics." (Doc. Inc.)

DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY - BATTERIES AND FUEL CELLS. II/La conversion directe de l'energie chimique en energie electrique - batteries et le piles a combustible. II. B. Lespinasse, Sciences et industries spatiales, vol. 1, no 7-8, 1965, p. 63-68., diagrs.,(A66-12482) (In French).

"Hydrogen fuel cells for space use noting Bacon cells, membrane cells and GEMINI and APOLLO fuel cells." (Doc. Inc.)

DIRECT ENERGY CONVERSION, LITERATURE ABSTRACTS. Dec. 1965, 156 p., (N66-21418). Naval Research Lab., Washington, D.C.

"Direct energy conversion literature abstracts." (Doc. Inc.)

DIRECT ENERGY CONVERSION SYSTEMS. Final Technical Report. R.H. Eustis, 29 Oct.1965, 25 p., (AFOSR-65-2013; N66-21521). Stanford Univ., Dept. of Mechanical Engineering, California.

"Magnetogasdynamic, fuel cell, and thermoelectric direct energy conversion systems." (Doc. Inc.)

ECONOMICS, LOGISTICS, AND OPTIMIZATION OF FUEL CELLS. G.C. Szego, Dec. 1965, 77 p., diagrs., (IDA/HQ-64-4226; P-208; X66-16097). Institute for Defense Analyses, Research and Engineering Support Div., Washington, D.C. "Available to U.S. Government agencies and their contractors only."

"Fuel cell economics, logistics, and optimization for military and civilian uses." (Doc. Inc.)

ELECTRICAL POWER SYSTEMS FOR THE MANNED ORBITING LABORATORY. M.R. Anderberg, Oct. 1965, 184 p., diagrs., (N66-17125). Princeton Univ., N.J.

"Solar cell, fuel cell, and secondary battery systems analysis for Manned Orbital Laboratory electrical power supply." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. Hydrogen Overvoltage at a Dropping Thallium Amalgam Electrode. E. A. Barron-Apps et al., Mar. 1965, 28 p., diagrs., (TM-17; X65-16287). Tyco Labs., Inc., Waltham, Mass.
"Available to U.S. Government agencies and their contractors only."

"Electrochemistry of fuel cell electrodes - hydrogen overvoltage measurements at dropping amalgam electrodes containing thallium." (Doc. Inc.)

ELECTROCHEMISTRY OF FUEL CELL ELECTRODES. Interfacial Tension of Indium Amalgams in 0.1 m $HClO_4$ at 25° C. J. N. Butler, Apr. 1965, 41 p., diagrs., (TM-19; X65-16412). Tyco Labs., Inc., Waltham, Mass.
"Available to U.S. Government agencies and their contractors only."

"Electrochemistry of fuel cell electrodes - measurements of interfacial tension for amalgams containing up to 64 percent indium." (Doc. Inc.)

ELECTROCHEMISTY OF FUEL CELL ELECTRODES. Semiannual Technical Summary Report, Period Ending March 30, 1965. A. C. Makrides, 1965, 8 p., (X65-16286). Tyco Labs., Inc., Waltham, Mass.
"Available to U.S. Government agencies and their contractors only."

"Fuel cell electrode catalytic activity improved through molecular basis of hydrogen oxidation and reduction, reduction of oxygen, and oxidation of formic acid." (Doc. Inc.)

ELECTROCHEMICAL OXIDATION OF SATURATED HYDROCARBONS. Interim Technical Report, 1 April - 31 October 1965. S.B. Brummer and J. Ginner,1965,108 p., illus., diagrs., (ITR-4; N66-22634). Tyco Labs., Inc., Waltham, Mass.

"Hot concentrated phosphoric acid, direct oxidation, hydrocarbon fuel cell." (Doc.Inc.)

ENGINEERING INVESTIGATION OF DIRECT LIQUID HYDROCARBON OXIDATION-AIR FUEL CELLS. Interim Technical Report, 22 September 1964 - 21 March 1965. 1965, 77 p., diagrs., (X66-12742). Onan Engine-Generator, Minneapolis, Minn. "Available to U.S. Government agencies only."

"Engineering study on direct liquid hydrocarbon oxidation fuel cells operating at intermediate temperatures." (Doc. Inc.)

AN EVALUATION OF FUEL CELL SYSTEMS FOR MILITARY VEHICLE PROPULSION AND PORTABLE ELECTRIC POWER GENERATION, Special Report No. 2. M. J. Schlatter, 1 Feb. 1965, 170 p., diagrs., (N65-17233). California Research Corp., Richmond.

"Fuel cell power systems for land vehicle propulsion and portable electric power generation." (Doc. Inc.)

AN EVALUATION OF MINIATURE FUEL CELLS FOR FUZE POWER APPLICATIONS. Special Report No. 4. M. J. Schlatter and M.A. Sweeney, 23 Dec. 1965, 73 p., diagrs., (X66-15734). Chevron Research Co., Richmond, Calif.
Available to U.S. Government agencies and their contractors only.

"Miniature fuel cells or hybrid battery-fuel cells for electronic fuse power supply." (Doc. Inc.)

EXTENDED MOLTEN-CARBONATE FUEL CELL SYSTEM PROGRAM. Final Report, 15 February - 30 November 1965. J.K. Truitt, Jan. 1966, 30 p., illus., diagrs., (TI-08-66-02; N66-27633). Texas Instruments, Inc., Dallas.

"Molten carbonate fuel cells." (Doc. Inc.)

FUEL CELL CATALYSTS. Second Quarterly Report, 1 August - 31 October 1965. O.J. Adlhart and A.J. Hartner, 1965, 47 p., illus., diagrs., (Rept. -2; X66-36393). Engelhard Industries, Inc., Research and Development Div., East Newark, N.J.
"Available to National Aeronautics and Space Administration offices and centers only."

"Platinum metals on carbon anodes for propane fuel cell catalysts at ambient temperatures." (Doc. Inc.)

500-WATT FUEL-CELL POWER PLANT. Interim Report, 1 October 1964 - 31 October 1965. T. Schiller, Jan. 1966, 44 p., illus., diagrs., (Rept. -1; N66-21483). Pratt and Whitney Aircraft, East Hartford, Conn.

"Portable, 500-watt, indirect, liquid hydrogen and air, fuel cell power plant." (Doc. Inc.)

FUEL CELL RESEARCH - AN INVESTIGATION OF NON-STEADY-STATE OPERATION. Final Report, 1 June 1963 - 1 June 1965. T.J. Gray et al., Dec. 1965, 36 p., diagrs., (NASA-CR-54768; N66-14786). Alfred Univ., N.Y.

"Application of galvanostatic studies to fuel cell electrodes - effects of pulsed loading on fuel cell operation." (Doc. Inc.)

FUEL CELL SERVES AS OXYGEN LEVEL DETECTOR. Mar. 1965, 2 p., diagrs., (NASA Tech Brief 65-10066). National Aeronautics and Space Administration, Washington, D.C.

The fuel cell monitors the oxygen level in the air with an output voltage that is proportional to the oxygen pressure encountered.

FUEL CELLS. H.J. Schwartz, 1965, 22 p., illus., diagrs., (NASA-TM-X-52149; N66-14769). National Aeronautics and Space Administration, Lewis Research Center, Cleveland, O.

"Hydrogen-oxygen fuel cells for spacecraft power systems." (Doc. Inc.)

FUEL CELLS. Status Report No. 5. S.J. Bartosh et al., Jun. 1965, 202 p., (N65-36322). Army Electronics Labs., Fort Monmouth, N.J.

"Fuel cell research programs." (Doc. Inc.)

60-WATT HYDRAZINE-AIR FUEL CELL SYSTEM. Interim Report 1 July - 1 November 1965. P.L. Terry, Feb. 1966, 51 p., diagrs., (ECOM-01460-1; MRB402811; N66-22673). Monsanto Research Corp., Boston Lab., Everett, Mass.

"Design and systems analysis of 60 watt hydrazine-air fuel cell system." (Doc. Inc.)

HYDROCARBON FUEL CELL ELECTRODES. Progress Report, 16 January - 16 July, 1965. V. Corso, Jr., Nov. 1965, 52 p., diagrs., (PR-1; N66-14518). American Cyanamid Co., Stamford Research Labs., Stamford, Conn.

"Fabrication and testing of hydrocarbon fuel cell electrodes." (Doc. Inc.)

HYDROGEN GENERATOR PROGRAM. Final Engineering Report, 21 June 1963 - 21 April 1965. E.J. Emerson and S.S. Kurpit, 1965, 80 p., diagrs., (X66-14070). Engelhard Industries, Inc, Process Equipment Div., East Newark, N.J.
"Available to U.S. Government agencies only."

"Engineering, design, and construction of hydrogen generators used with fuel cells to constitute electric power sources." (Doc. Inc.)

HYDROGEN OXYGEN FUEL CELL SYSTEM DESIGN PARAMETERS. (Energy Conversion and Storage, Proceedings of the Annual Conference, 3rd, Oklahoma State Univ., Stillwater, Okla., Oct. 28-29, 1965) B. Linville, editor. N.A. Cook and B. Linville, 1965, p. 2-1 to 2-14, illus., diagrs., (A66-16391). Oklahoma State Univ., Engineering and Industrial Extension, Stillwater, Okla.

"Fuel cell systems, particularly hydrogen peroxide type, noting electrochemical oxidation, water production, thermal energy, electrolyte, etc." (Doc. Inc.)

INORGANIC ION EXCHANGE MEMBRANES FUEL CELL. Final Report. C.B. Berger and M.P. Strier, Oct. 1965, 177 p., illus., diagrs., (NASA-CR-54784; SM-46221-F; N66-15227). Douglas Aircraft Co., Inc., Astropower Lab., Santa Monica, Calif.

"Inorganic ion exchange membranes fuel cell - development of zirconium phosphate membrane impregnated with catalyst." (Doc. Inc.)

AN INTRODUCTION TO FUEL CELLS. E.M. Cohn, 1965, 16 p., (NASA-TM-X-57300; N66-19612). National Aeronautics and Space Administration, Washington, D.C.

"Definition, classification, and industrial potential of fuel cells." (Doc. Inc.)

HYDROCARBON-AIR FUEL CELLS. Semiannual Technical Summary Report, 1 July - 31 December 1965. 1965, 251 p., illus., diagrs., (TSR-8; X66-17670). General Electric Co., Lynn, Mass.
"Available to U.S. Government agencies only."

"Electrochemical oxidation, electrocatalyst, electrolyte, electrode, and fuel cell lifetime studies in hydrocarbon-air fuel cell development for military applications." (Doc. Inc.)

HYDROCARBON-AIR FUEL CELLS. Semi-Annual Technical Summary Report No. 7, 1 January 1965 - 30 June 1965. 1965, 284 p., diagrs., (GE TSR #7). Army, Engineer Research and Development Laboratories, Ft. Belvoir, Virginia; General Electric Co., Lynn, Mass.

"Reports on investigations aimed at developing an integrated fuel cell technology for cells using ambient air and hydrocarbon fuels. Includes research on electrochemical oxidation of hydrocarbons, electrocatalysts, electrode structure, multicomponent fuels and electrochemical cell life testing." (Author)

HYDROCARBON-AIR FUEL CELL. Semiannual Report No. 3, 1 January - 30 June 1965. W.R. Epperly et al., 1965, 325 p., illus., diagrs., (PCRD-4M-65; X66-12878). Esso Research and Engineering Co., Process Research Div., Linden, N.J.
"Available to U.S. Government agencies and their contractors only."

"Methyl alcohol-air and hydrocarbon-air fuel cells." (Doc. Inc.)

AN INVERTER FOR OPTIMIZATION STUDIES OF A FUEL-CELL SYSTEM, SEPTEMBER 1964 - JANUARY 1965. E.J. Dowgiallo, Jr., Aug. 1965, 37 p., diagrs., (Rept. -1825; X66-11884). Army Engineer Research and Development Labs., Fort Belvoir, Va.
"Available to U.S. Government agencies and their contractors only."

"Inverter to provide sine wave output by step wave approximation - use of analog computer inverter model to simulate effects of inverter loads on fuel cell powered system." (Doc. Inc.)

INVESTIGATIONS LEADING TO THE DEVELOPMENT OF A PRIMARY ZINC-SILVER OXIDE BATTERY OF IMPROVED PERFORMANCE CHARACTERISTICS. Final Report, 1 July 1964 - 30 June 1965. B.R. Hawkins, 1965, 81 p., diagrs., (NASA-CR-68563; N66-13637). Eagle-Picher Co., Couples Dept., Joplin, Mo.

"Design of silver oxide-zinc battery of limited cycle life with no degradation in discharge voltage characteristics." (Doc. Inc.)

INVESTIGATIVE STUDY RELATING TO FUEL CELLS - PLATINUM PHOSPHIDES. Summary Report, 1 July 1964 - 30 June 1965. 16 Sep. 1965, 43 p., illus., diagrs. (X66-12182). Chevron Research Co., Richmond, Calif.
"Available to U.S. Government agencies and their contractors only."

"Platinum phosphide for use as catalyst in oxidation of fuel cell materials - hydrogen, hydrazine, methanol, ethylene, and ethane." (Doc. Inc.)

LIQUID HYDROCARBON FUEL CELL DEVELOPMENT. Final Technical Report, 27 July 1964 - 27 January 1965. J.W. Allison et al., 73 p., illus., diagrs., (PWA-2549; N65-19458). Pratt and Whitney Aircraft, East Hartford, Conn.

"Liquid hydrocarbon fuel cell development - cell variables effect on performance, catalytic activity, and fuel comparison." (Doc. Inc.)

LIQUID HYDROCARBON FUEL CELL DEVELOPMENT, PHASE II. Technical Report, 27 January - 27 August 1965. H.H. Heilbronner et al., 23 Aug. 1965, 65 p., illus., diagrs., (PWA-2656; N65-20433). Pratt and Whitney Aircraft, East Hartford, Conn.
"Available to U.S. Government agencies only."

"Liquid hydrocarbon fuel cell with palladium-silver anode." (Doc. Inc.)

MINIATURE HYDROGEN GENERATOR. Second Quarterly Report, 1 September - 30 November 1965. L.M. Litz and J.E. Rothfleisch, Feb. 1966, 42 p., illus., diagrs., (ECOM-01375-2; N66-22733). Union Carbide Corp., Parma Technical Center, Parma, O.

"Portable power heat generator to produce hydrogen by cracking liquid hydrocarbons for operating hydrogen-air fuel cell." (Doc. Inc.)

MULTI-PURPOSE ENGINE AND FUEL SYSTEM - LUNAR EXPLORATION SYSTEMS FOR APOLLO. Summary digest. 1965, 33 p., diagrs., (NASA-CR-57636; WANL-PR/S/-006-B; X65-18283). Westinghouse Electric Corp., Astronuclear Lab., Pittsburgh, Pa.
"Available to U.S. Government agencies and their contractors only.

"Fuel cell for multi-purpose engine and fuel system - design of modular fuel supply and regeneration system for lunar exploration - APOLLO project." (Doc. Inc.)

A NEW APPROACH TO HIGH-PRESSURE HIGH-TEMPERATURE FUEL CELL ELECTRODE DESIGN. (Energy Conversion and Storage, Proceedings of the Annual Conference, 3rd, Oklahoma State Univ., Stillwater, Okla., Oct. 28-29, 1965) B. Linville, editor. H.J. Allison, 1965, p. 4-1 to 4-11, illus., diagrs. (A66-16392). Oklahoma State University, Engineering and Industrial Extension, Stillwater, Okla.

"High-pressure high-temperature hydrogen-oxygen fuel cells employing nonnoble metal catalyst (porous nickel) as electrode."(Doc. Inc.)

OPERATION STABILITY OF THE APOLLO FUEL-CELL CONDENSER. M. B. Weinstein, June 1965, 22 p., illus., diagrs., (NASA-TM-X-1100). National Aeronautics and Space Administration, Washington, D.C.

Reports on an evaluation of the APOLLO fuel-cell condenser stability.

POWER SUBSYSTEMS FOR APPLICATION TO A MILITARY COMMUNICATIONS SATELLITE. Technical Report, 1 December 1964 - 12 January 1965. G.B. Stafford, Sep. 1965, 34 p., diagrs., (AFAPL-TR-65-64; X66-14280). Air Force Systems Command, Wright-Patterson AFB, O.
"Available to U.S. Government agencies and their contractors only."

"Power subsystems for military communications satellite." (Doc. Inc.)

REGENERATIVE FUEL CELL COMBINES HIGH EFFICIENCY WITH LOW COST. H. Doyle et al., Dec. 1965, 2 p., diagrs., (NASA Tech Brief 65-10363). National Aeronautics and Space Administration, Washington, D.C.

A hydrogen/oxygen regenerative fuel cell which achieves a high energy to weight ratio at a low cost.

RESEARCH AND DEVELOPMENT OF OPEN-CYCLE FUEL CELLS. Fourth Quarterly Progress Report, Period Ending August 15, 1965. R. Desai et al., 15 Sep. 1965, 24 p., diagrs., (NASA-CR-67802; NAS-8-5392-QPR-004; N66-10601). Allis-Chalmers Mfg. Co., Research Div., Milwaukee, Wis.

"Digital computer program for minimizing weight of fuel cell power systems - prelaunch startup and instrumentation - mathematical model of static moisture removal process - fuel cell model." (Doc. Inc.)

RESEARCH AND DEVELOPMENT ON FUEL CELL SYSTEMS. Sixth Quarterly Progress Report, 1 October - 31 December 1965. 1966, 124 p., illus., diagrs., (NASA-CR-74096; NAS-8-2696-QPR-006; N66-23499). Allis-Chalmers Mfg. Co., Research Div., Milwaukee, Wis.

"Hydrogen-oxygen fuel cell power systems design, fabrication, and testing." (Doc. Inc.)

REVERSIBLE OXYGEN ELECTRODES. Second Quarterly Report, 14 July - 14 October 1965. A. Damjanovic et al., 1965, 40 p., diagrs., (Rept. - 2; N66-22481). Pennsylvania Univ., Electrochemistry Lab., Philadelphia.

"Oxygen reduction at rhodium electrodes using rotating disk electrode." (Doc. Inc.)

SERIES "S" ION EXCHANGE MEMBRANE FUEL CELL TEST PROGRAM. 7 Oct. 1965, 66 p., General Electric, Direct Energy Conversion Operation, West Lynn, Mass.

"A progress report on General Electric Series "S" Ion Exchange Membrane Fuel Cells is given in complete detail. This includes a history of all tests being run and a summary of all data compiled to date, including product water $_{p}$H history." (Author)

SILENT, LIQUID HYDROCARBON-AIR FUEL CELL POWERPLANT. Volume I - Text Interim Technical Report, 18 March - 18 September 1965. S.J. Keating, Jr., 8 Oct. 1965, 82 p., (PWA-2678, vol.I; N66-18622). Pratt and Whitney Aircraft, East Hartford, Conn.

"Fuel cell module and hydrogen generator reference design system for development of liquid hydrocarbon-air fuel cell power plant." (Doc. Inc.)

SILENT, LIQUID HYDROCARBON-AIR FUEL CELL POWERPLANT. Volume II - Figures and Tables. Interim Technical Report, 18 March - 18 September 1965. S.J. Keating, Jr., 8 Oct. 1965, 91 p., illus., diagrs., (PWA-2678, vol. II; N66-19028). Pratt and Whitney Aircraft, East Hartford, Conn.

"Silent, liquid hydrocarbon-air fuel cell power supply design details and performance evaluation." (Doc. Inc.)

SOLUBILITY AND DIFFUSIVITY OF HYDROCARBONS AND OXYGEN IN FUEL CELL ELECTROLYTES, Final Report. K.E. Gubbins, 30 Jun. 1965, 67 p., diagrs., (N65-36247). Florida Univ., Engineering and Industrial Experiment Station, Gainesville.

"Solubility and diffusivity of hydrocarbons and oxygen in fuel cell electrolytes." (Doc. Inc.)

SOME ASPECTS OF THE IONIZATION AND EVOLUTION OF HYDROGEN ON PLATINUM ELECTRODES IN ACID SOLUTION. R.D. Chamberlin, Dec. 1965, 236 p., diagrs., (Rept. -9; X66-16986). Pennsylvania State Univ., Dept. of Fuel Science, University Park.
"Available to U.S. Government agencies and their contractors only."

"Hydrogen ionization and evolution on platinum electrodes of fuel cells." (Doc. Inc.)

STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS. Quarterly Progress Report, 1 October - 31 December 1965. J.O. Bokris, 1965, 80 p., diagrs., (NASA-CR-71548; N66-21820). Pennsylvania Univ., Electrochemistry Lab., Philadelphia.

"Studies in fundamental chemistry of fuel cell reactions." (Doc. Inc.)

STUDY OF ENERGY CONVERSION SYSTEMS. Summary Report, August 31, 1964 - August 15, 1965. R. Desai et al., 15 Jan. 1966, 142 p., diagrs., (NASA-CR-74121; NAS-8-5392-SR-001; X66-16234). Allis-Chalmers Mfg. Co., Research Div., Milwaukee, Wis.
"Available to U.S. Government agencies and their contractors only."

"Energy conversion systems - fuel cell power system evaluation and computer program for parametric optimization." (Doc. Inc.)

STUDY PROGRAM TO IMPROVE FUEL CELL PERFORMANCE BY PULSING TECHNIQUES. Final Report, Quarter Ending August 31, 1965. M.L Kronenberg, 1965, 73 p., illus., diagrs., (NASA-CR-54767; N66-12168). Union Carbide Corp., Research Lab., Parma, O.

"Heavy discharge pulsing to improve fuel cell electrode performance." (Doc. Inc.)

SURVEY OF ELECTRIC POWER PLANTS FOR SPACE APPLICATIONS. H.J. Schwartz and L.I. Shure, 1965, 39 p., illus., diagrs., (NASA-TM-X-52158; N66-14775). National Aeronautics and Space Administration, Lewis Research Center, Cleveland, O.

"Fuel and solar cells, chemical batteries, Rankine and Brayton cycle power plants, thermoelectric generators, and thermionic converters for space power applications." (Doc. Inc.)

SYSTEM SELECTION FOR A LOW-TEMPERATURE FUEL CELL POWERPLANT. (Symposium on Fuel Cell Systems and Processes, Part I, American Institute of Chemical Engineers, Annual Meeting, 58th, Philadelphia, Pa., Dec. 5-9, 1965) J.W. Connors et al., Preprint 13B., 14 p., illus., diagrs., (A66-21182).

"System selection for hydrogen-oxygen low temperature fuel cell with aqueous KOH electrolyte." (Doc. Inc.)

TEST OF GEMINI FUEL BATTERY SECTION TO MANNED ORBITING LABORATORY MISSION POWER REQUIREMENTS. Technical Report, February - May 1965. L.J. Nuttal and L.R. Stevens, Jr., Jun. 1965, 37 p., illus., diagrs., (AFAPL-TR-65-77; X65-19335). General Electric Co., Direct Energy Conversion Operation, Lynn, Mass.
"Available to U.S. Government agencies and their contractors only."

"GEMINI fuel battery section test to Manned Orbital Laboratory Mission Power Requirements." (Doc. Inc.)

A TRANSIENT HEAT TRANSFER AND THERMODYNAMIC ANALYSIS OF THE APOLLO SERVICE MODULE PROPULSION SYSTEM. V. I, Phase I - Transient Thermal Analysis, Final Report, 28 July 1964 - 28 July 1965. B. A. Nevelli et al., 10 Aug. 1965, 446 p., illus., diagrs., (NASA-CR-65331; LR-18899, vol. I; N66-22352). Lockheed-California Co., Burbank.

"Transient heat transfer and thermodynamic behavior analysis for APOLLO service module propulsion system - fuel cell effect on overheating." (Doc. Inc.)

TRANSPORT PROCESSES IN ELECTRODE SYSTEMS. Final Report, March 16, 1962 - March 1, 1965. D.N. Bennion et al., Mar. 1965, 259 p., illus., diagrs., (N66-16726). Univ. of California, Berkeley.

"Transport properties of electrochemical cells." (Doc. Inc.)

1966

AES PRELIMINARY DEFINITION PHASE APOLLO EXTENSION SYSTEM FINAL REPORT. Allis-Chalmers Fuel Cell Study - Program Analysis. 8 Feb. 1966, 109 p., diagrs., (NAA-SID 65-1543-2). North American Aviation, Inc., Space and Information Systems Division.

"This document describes the technical and managerial aspects relating to the use of the Allis-Chalmers fuel cell electrical power source for Phase II APOLLO Applications Missions." (Author)

AES PRELIMINARY DEFINITION PHASE APOLLO EXTENSION SYSTEM FINAL REPORT. Allis-Chalmers Fuel Cell Study - Technical Summary. 31 Jan. 1966, 328 p., illus., diagrs., (NAA-SID 65-1543-1). North American Aviation, Inc., Space and Information Systems Division.

"The Allis-Chalmers fuel cell power plant is analyzed to determine compatibility with the APOLLO Extension System mission requirements and objectives." (Author)

ALLISON RESEARCH AND ENGINEERING, Volume No. 2, Second Quarter 1964. 1964, 20 p., illus., diagrs., N65-11879. General Motors Corp., Allison Div., Indianapolis, Ind.

"Laboratory techniques for quantitative material testing, thermally regenerative fuel cells." (Doc. Inc.)

DESIGN OF HYDROGEN-OXYGEN CAPILLARY TYPE FUEL CELL. Quarterly Technical Progress Report, 1 November 1965 - 31 January 1966. 15 Feb. 1966, 28 p., illus., diagrs., (QTPR-9; N66-22469). Allis-Chalmers Mfg. Co., Space and Defense Sciences Dept., Milwaukee, Wis.

"Hydrogen-oxygen capillary type fuel cell design and development." (Doc. Inc.)

DEVELOPMENT OF CATHODIC ELECTROCATALYSTS FOR USE IN LOW TEMPERATURE H_2/O_2 FUEL CELLS WITH AN ALKALINE ELECTROLYTE. Third Quarterly Report, January 1 - March 31, 1966. J. Giner et al., 1966, 102 p., diagrs., (NASA-CR-75199; N66-26759). Tyco Labs., Inc., Waltham, Mass.

"Metal, alloy, and metal compound testing for corrosion resistance and activity as oxygen electrodes for hydrox fuel cell with alkaline electrolyte." (Doc. Inc.)

DEVELOPMENT OF HIGH-PERFORMANCE LIGHT-WEIGHT ELECTRODES FOR HYDROGEN-OXYGEN FUEL CELLS. Third Quarterly Report, 6 October 1965 - 5 January 1966. W.P. Colman et al., 15 May 1966, 73 p., diagrs., (NASA-CR-54955; N66-25164). American Cyanamid Co., Research Labs., Stamford, Conn.

"High performance, lightweight electrodes for hydrogen-oxygen fuel cells." (Doc. Inc.)

GASEOUS ELECTROLYTES FOR BATTERIES AND FUEL CELLS. Sixth Quarterly Report, 21 November 1965 - 20 February 1966. S. Naiditch, 1966, 46 p., diagrs., (NASA-CR-74671; N66-24976). Unified Science Associates, Inc., Pasadena, Calif.

"Conductivity cells for investigations of gaseous electrolytic solutions." (Doc. Inc.)

HYDROGEN-OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS. Quarterly Report, 1 January - 31 March 1966. E. Findle and M.G. Klein, 27 Apr. 1966, 60 p., diagrs., (NASA-CR-74419; EOS-4110-QL-7; N66-23513). Electro-Optical Systems, Inc., Pasadena, Calif.

"Hydrogen-oxygen regenerative fuel cell testing to improve cycle life capability and to investigate modes of cell performance deterioration." (Doc. Inc.)

LATERAL DIFFUSION ELECTRODES, PART IV. (Translated from Thesis - Electrodes a Diffusion Laterale, Section IV, Paris,1965) D. Doniat, Jan. 1966, 37 p., diagrs., (NASA-TT-F-9852; N66-16576). National Aeronautics and Space Administration, Washington, D.C.

"Lateral diffusion electrodes manufactured by powder metallurgy for fuel cells - diffusion processes in active carbon coating." (Doc. Inc.)

LOW TEMPERATURE FUEL CELL SYSTEMS. (Symposium on New Energy Conversion Systems, American Institute of Chemical Engineers, National Meeting, 58th, Dallas, Tex., Feb. 6-9, 1966) N.I. Palmer, Preprint 15D., 23 p., illus., diagrs., (A66-21192).

"Fuel cell systems operating at low temperatures, noting control loops, hydrogen/oxygen, nickel electrode, asbestos systems, etc." (Doc. Inc.)

PURIFICATION OF FUEL CELL GASES. Final Report, 21 July 1965 - 28 February 1966. T.D. Bath and A.D. McElroy, 23 Feb. 1966, 43 p., diagrs., (NASA-CR-65284; N6621008). Midwest Research Inst., Chemistry Div., Kansas City, Mo.

"In-flight purification methods for oxygen and hydrogen gases used in APOLLO fuel cell." (Doc. Inc.)

REACTION HEAT USED IN STATIC WATER REMOVAL FROM FUEL CELLS. 1966, 2 p., diagrs., (NASA Tech Brief 66-10013). National Aeronautics and Space Administration, Washington, D.C.

A portion of the heat inherent in a fuel cell current generator is used to transform excess water into water vapor which is then removed by a porous vapor transport membrane.

RESEARCH IN THE CONVERSION OF VARIOUS FORMS OF ENERGY BY UNCONVENTIONAL TECHNIQUES. Status Report. M. Altman, 1 Apr. 1966, 157 p., diagrs., (NASA-CR-75115; N66-26653). Pennsylvania Univ., Institute for Direct Energy Conversion, Philadelphia.

"Engineering developments in plasma probes, ionized gas, electron emission, electrochemical fuel cells, solar-thermal energy conversion, and nonlinear heat transfer phenomena." (Doc. Inc.)

RESILIENT CLAMP HOLDS FUEL CELL STACK THROUGH THERMAL CYCLE. Feb. 1966, 2 p., diagrs., (NASA Tech Brief 66-10035). National Aeronautics and Space Administration, Washington, D.C.

A resilient clamping device holds a stack of fuel cells and maintains seal integrity over a wide stress range by means of torsion bar action.

SMALL FUEL CELL TO ELIMINATE PRESSURE CAUSED BY GASSING IN HIGH ENERGY DENSITY BATTERIES. Progress Report, 30 December 1965 - 31 March 1966. H. Frank and M.P. Strier, Apr. 1966, 40 p., illus., diagrs., (NASA-CR-74504; SM-48457-Q3; N66-23596). Douglas Aircraft Co., Inc., Astropower Lab., Newport Beach, Calif.

"Miniature fuel cell as pressure regulators in silver-zinc batteries." (Doc. Inc.)

STUDY OF FUEL CELLS USING STORABLE ROCKET PROPELLANTS. Quarterly Report No. 4, 19 November 1965 - 18 February 1966. R.F. Drake, et al., 28 Feb. 1966, 59 p., illus., diagrs., (NASA-CR-54921; MRB5009Q4; N66-23467). Monsanto Research Corp., Everett, Mass.

"Fuel cell systems using storable propellants as primary or secondary reactants." (Doc. Inc.)

A STUDY OF GAS SOLUBILITIES AND TRANSPORT PROPERTIES IN FUEL CELL ELECTROLYTES. First Semiannual Report 1 September 1965 - 28 February 1966. R.D. Walker, 15 Mar. 1966, 57 p., diagrs., (NASA-CR-74779; N66-24957. Univ. of Florida, Engineering and Industrial Experiment Station, Gainesville.

"Oxygen and hydrogen solubility and transport properties in fuel cell electrolytes." (Doc. Inc.)

STUDY OF THE USE OF AUXILIARY ELECTRODES IN SILVER CELLS. W.N. Carson, Jr. et al., Mar. 1966, 39 p., diagrs., (NASA-CR-405). National Aeronautics and Space Administration, Washington, D.C.

"This report covers the work done on the use of auxiliary electrodes in silver-zinc cells, the design and development of a hydrogen combination cell, and the testing of silver-cadmium cells with auxiliary electrodes." (Author)

THERMODYNAMIC PROPERTIES OF PU COMPOUNDS FROM EMF MEASUREMENTS. 1. Pu Versus Ag in LiCl-KCl Eutectic. G.M. Campbell and J.A. Leary, 1 Mar. 1966, 18 p., diagrs., (LA-3399; N66-27253). Los Alamos Scientific Lab., N. Mex.

"Thermodynamic properties of plutonium compounds obtained by measuring electromotive force of electrochemical cells." (Doc. Inc.)

THIN FUEL CELL ELECTRODES. Quarterly Progress Report No. 3, 1 November 1965 - 31 January 1966. M.B. Clark and K.V. Kordesch, Apr. 1966, 50 p., diagrs., (Its Rept. -7; N66-27645). Union Carbide Corp., Research Lab., Parma, O.

"Thin fuel cell electrodes." (Doc. Inc.)

USE OF THE ADSORPTION HYDROGEN ELECTRODE AND THE OXYGEN FUEL-CELL ELECTRODE IN NICKEL-CADMIUM CELLS. K.O Sizemore, Apr. 1966, 30 p., diagrs., (NASA-TM-X-55469; X716-66-83; N66-24926). National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

"Characteristics and use of adsorption hydrogen electrode and oxygen fuel-cell electrode in nickel-cadmium cells." (Doc. Inc.)

VAPOR DIFFUSION ELECTRODE IMPROVES FUEL CELL OPERATION. Jun. 1966, 2 p., diagrs., (NASA Tech Brief 66-10281). National Aeronautics and Space Administration, Washington, D.C.

"A vapor diffusion-type electrode presents a non-wetting barrier to the liquid feed stocks so that they may contact the electrolyte only in the vapor state." (Author)

PERIODICALS

1964

APOLLO FUEL CELL PROGRESS TERMED 'SOUND'. A. P. Alibrando, Aviation Week and Space Technology, 20 Jan. 1964, 80:32-33. illus.

A progress report on Pratt and Whitney APOLLO fuel cell development. The principal problems remaining are weight reduction and increasing operational life.

THE APOLLO SPACECRAFT ELECTRICAL POWER DISTRIBUTION SYSTEM. T. C. Quebedeaux, IEEE Transactions on Aerospace, Apr. 1964, AS 2:472-477. (A64-18135)

"APOLLO spacecraft command and service module uses fuel cells as primary electrical energy source and storage batteries during reentry and landing." (Doc. Inc.)

ARMY RECRUITS A FUEL CELL THAT RUNS ON ANY HYDROCARBON. Machine Design, 5 Nov. 1964, 36:12. illus.

Describes a fuel-cell system which accepts any hydrocarbon and operates at extremely high temperatures. Military advantages are silent operation, low maintenance and high efficiency.

EMERGENCY AUXILIARY POWER FOR LONG DURATION MISSIONS. (AIAA Annual Meeting, 1st, Washington, D.C., June 29 - July 2, 1964) C. H. Shinbrot, AIAA paper, 64-447. 8 p. (A64-28575)

"Emergency auxiliary power systems for long duration space missions." (Doc. Inc.)

FUEL CELL DEVELOPMENTS KEEP COMING APACE. F. C. Price, Chemical Engineering, 6 Jan. 1964, 71:32,34. illus., diagrs.

Contains a description of hydrogen-air battery, hydrocarbon-air fuel cells and a flooded, porous electrode system.

FUEL CELL ORBITAL EXPERIMENT. N. P. Bannerton and R. L. Kerr, IEEE Transactions on Aerospace, Apr. 1964, AS 2:789-799. (A64-18177)

"Design fabrication and environmental evaluation of capillary type hydrogen-oxygen fuel cell." (Doc. Inc.)

FUEL CELLS. P. Roman, Space/Aeronautics, Aug. 1964, 42:70-75. (A64-23477)

"Fuel cell possibilities as means of converting chemical into electrical energy for aerospace use." (Doc. Inc.)

FUEL CELLS: A STATE-OF-THE-ART REPORT. Pt. 1. R. J. Jasinski and T. G. Kirkland, Mechanical Engineering, Mar. 1964, 6:51-57. diagrs., illus.

Reports on classification of fuel cells. Various fuel cells are described and types of fuels are discussed.

G.E.'s GEMINI/BIOS FUEL CELL PROGRESSES. Missiles and Rockets, 2 Nov. 1964, 15:35. illus.

Newsnote on current progress in the GEMINI and BIOS fuel cell program.

GEMINI FUEL CELL READIED FOR GT-2 FLIGHT, NOW SCHEDULED FOR SEPTEMBER. M. Getler, Missiles and Rockets, 8 Jun. 1964, 14:29-34. diagrs.

Describes G.E.'s GEMINI fuel-cell system. Other feasible space applications are discussed. G.E.'s "no moving parts" system is a unique feature of the fuel-cell system.

A LABORATORY DEMONSTRATION FUEL CELL. J. G. Bannochie, Journal of Scientific Instruments, Oct. 1964, 41:644-645. (A64-27385)

"Laboratory demonstration fuel cell consisting of two cation exchange membranes with platinum bonded to their outer sides and sulphuric acid between them." (Doc. Inc.)

LOW TEMPERATURE FUEL BATTRIES ON THE MOON. J. G. Bartas, IEEE Transactions on Aerospace, Apr. 1964, AS 2:800-806. (A64-18178)

"Heat rejection of fuel battery power supply systems for lunar stations." (Doc. Inc.)

NEW RESULTS WITH ELECTROCHEMICAL FUEL CELLS USING LIQUID FUELS/ Neve Ergebnisse an Brennstoffzellen mit fluessigen Brennstoffen. (Wissenschaftliche gesellschaft fuer luft und Raumfahrt and Deutsche Gesellschaft fuer Raketentechnik und Raumfahrtforschung, Jahrestagung, Berlin, West Germany, Sept. 14-18, 1964) W. Herrmann, 26 p.,(A64-27157) (In German)

"Fuel cell operation utilizing liquid fuels, evaluating hydrazine and alcohol fuels and electrode materials." (Doc. Inc.)

OPEN CYCLE FUEL CELL SYSTEM FOR SPACE APPLICATIONS. (American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29 - Dec. 4, 1964) E. O. Cheney, Jr. et al., ASME paper 64-WA/AV-15. 12 p., (A65-13413)

"Open cycle Bacon cell space power system using cryogenically stored hydrogen with good heat and water rejection capacities." (Doc. Inc.)

POTASSIUM-WATER-OXYGEN FUEL CELL BATTERIES FOR SPACE APPLICATION. (American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29 - Dec. 4, 1964) T. G. Bradley and R. E. Henderson, ASME paper 64-WA/ ENER-3. 17 p., (A65-13126)

"Potassium-water-oxygen fuel cell, operational components and weight optimization for space applications." (Doc. Inc.)

POWER SUPPLIES. F. Schulman et al., Space/Aeronautics, Sep. 1964, 42:101-105. (A64-28086)

"Power supplies for spacecraft including static and dynamic solar systems, batteries, fuel cells and nuclear systems." (Doc. Inc.)

SPACE POWER SYSTEMS -- PART 2: BATTERY RELIABILITY ENSURES CONTINUED USE. M. L. Yaffee, Aviation Week and Space Technology, 1 Jun. 1964, 80:49,51,54,55,57. illus.

Regenerative hydrogen-oxygen fuel cells may prove competitive with secondary batteries. (The report includes a list of representative fuel-cell systems.)

SPECIAL DESIGN CONSIDERATIONS FOR THE APOLLO SPACECRAFT ELECTRICAL SYSTEM. P. Fono, IEEE Transactions on Aerospace, Apr. 1964, AS 2:467-471. (A64-18134)

"Switch gear for APOLLO Spacecraft fuel cell system eliminates circuit breakers and diodes and substitutes solid state relay operated switches." (Doc. Inc.)

VOLTAGE AND CURRENT CONTROL FOR SPACECRAFT FUEL-CELL SYSTEMS. G. W. Bills, IEEE Transactions on Aerospace, Apr. 1964, AS 2:478-482. diagrs., (A64-18136)

"Feedback control system for regulating output voltage and currents of spacecraft elective power system consisting of parallel fuel cell modules." (Doc. Inc.)

WATER RECOVERY FROM FUEL CELLS AND LUNAR MINERALS. F. J. Hendel, I&EC, Mar. 1964, 56:29-31. diagrs. (A64-15525).

"Water recovery from fuel cells and moon minerals for long duration life support of space missions." (Doc. Inc.)

1965

THE ADSORPTION AND OXYDATION OF HYDROCARBONS ON NOBLE METAL ELECTRODES. I. PROPANE ADSORPTION ON SMOOTH PLATINUM ELECTRODES. S.B. Brummer et al., The Journal of Physical Chermistry, Oct. 1965, 69:3424-3433. diagrs.

Reports the basic mechanisms of the oxydation of saturated hydrocarbon in a fuel cell.

ARMY PRESSES FOR BETTER FIELD SYSTEMS. Missiles and Rockets, 29 Mar. 1965, 16:77-78,81. illus.

Evaluation of new power sources (including fuel cell research and development) used by the army.

THE DEGREE OF COUPLING AND EFFICIENCY OF FUEL CELLS AND MEMBRANE DESALINATION PROCESS. S. R. Caplan, The Journal of Physical Chemistry, Nov. 1965, 69:3801-3804.

Methods for determining the degree of coupling and maximum efficiency of energy conversion in desalination processes and fuel cells.

ECONOMICAL 5-KW FUEL CELL BIDS FOR FIELD WORK. Machine Design, 4 Feb. 1965, 37:14. illus.

Announces a British fuel cell which operates on methanol and air at atmospheric pressure and only slightly above room temperature. Plastics are used throughout the cell to keep the weight low.

ELECTRICAL ENERGY FROM MICROORGANISMS. J. Brake et al., Chemical Engineering Process, Dec. 1965, 61:65-68. (A66-15478)

"Utilization of microorganisms to generate electrical energy." (Doc. Inc.)

ENERGY GENERATION AND CONVERSION. E. V. Somers, Chemical Engineering, 10 May 1965, 72:167-174. diagrs.

Discusses fuel cell development and the problems which must be solved before fuel cells will be widely used.

FUEL CELL MEMBRANE PERMEATION MEASUREMENTS USING A GAS CHROMATOGRAPH. R. P. Hamlen et al., I&EC Product Research and Development, Sep. 1965, 4:251-252 . (A66-14539)

"Gas permeation measurements on ion exchange fuel cell membranes using chromatography." (Doc. Inc.)

FUEL CELL POWER ADVANCES TO 5-KW LEVEL. H. Bierman, Electronic Design, 21 Jun. 1965, 13:6-9.

Describes current improvements in fuel cells and gives details about the GEMINI fuel-cell system. Solar cells and thermoelectric generators are also mentioned.

FUEL CELL,THERMIONIC CONVERTER MAKE PROGRESS. Electrical World, 5 Apr. 1965, 163:70. illus.

Describes a high-temperature (1800°F) fuel-cell battery, consisting of 400 thimble-sized fuel cells, which uses coal as a fuel.

FUEL CELLS "EVER-RECEDING SIX MONTHS". Product Engineering, 19 Jul. 1965, 36:52-53.

Reports on a fork-lift truck powered by a fuel cell. Many major problems must be solved before production models will reach the market.

GEMINI 5; THAT BALKY FUEL CELL. Product Engineering, 13 Sep. 1965, 36: 105-106. illus., diagrs.

Reports on the technologic problems encountered in the fuel-cell system during the flight of GEMINI 5.

METHANOL FUEL CELL SHOWS PROMISE. Power, Jul. 1965, 109:60-61. diagrs.

A small, low-temperature methanol fuel cell is described. These fuel cells are moderate in cost and reasonably efficient and can be used in isolated areas where reliability is important.

NON-NUCLEAR POWER SUPPLIES. Alfred Krausz, Space/Aeronautics, Jul. 1965, 44:118-122. (A65-33614)

"Solar power, alkaline batteries and fuel cells as spacecraft power source, noting designs and problems." (Doc. Inc.)

PERFORMANCE AND LIFE TESTING OF A 1.5 KW ALLIS CHALMERS FUEL CELL. G. F. Turner and A. N. Himle, IEEE Transactions on Aerospace, Jun. 1965, AS 3(no. 2):550-551. illus., diagrs., (A65-31135)

Describes the test setup, procedure, and preliminary results of a test program to determine the operating characteristics and life of a 1.5 kw Allis-Chalmers fuel cell.

THE PERFORMANCE OF COBALT ELECTRODES IN HIGH-TEMPERATURE FUEL CELLS. H. R. Gibbens and R. L. Moss, Cobalt, Sep. 1965, p. 115-120. illus., diagrs.,(A66-10358)

"Cobalt electrode performance in high temperature fuel cells, presenting V-I characteristics." (Doc. Inc.)

PERFORMANCE OF A NICKEL BORIDE FUEL CELL ANODE USING HYDROGEN AND ETHYLENE. R. Thacker, Nature, 10 Apr. 1965, 206:186,187.

"Electric potential of nickel boride fuel cell anode using hydrogen and ethylene." (Doc. Inc.)

POWER SOURCES, FUEL CELLS, ELECTRICITY PLUS WATER. Product Engineering, 2 Aug. 1965, 36:39,40. diagrs.

Describes the fuel-cell system planned for GEMINI 5. The fuel cell is subject to deterioration between activations because of contaminants.

RELIABLE ENERGY CONVERSION POWER SYSTEMS FOR SPACE FLIGHT. J. T. Lingle, IEEE Transactions on Aerospace, Jun. 1965, AS 3(no. 2, supp.):543-549. illus., diagrs.,(A65-31134)

Transistor-converters can be used to boost thermionic converters and fuel cells to a higher more usable regulated voltage.

SECONDARY POWER GENERATING SYSTEM FOR A MANNED LOGISTIC SPACECRAFT. C. H. Shinbrot, IEEE Transactions on Aerospace, Jun. 1965, AS 3(no. 2, supp.):568-576. illus., diagrs.,(A65-31138)

Fuel cells, batteries, Stirling engines, internal combustion engines and turbines are evaluated on the basis of performance, weight, radiator area and availability for use as a secondary power-generating system.

SIMPLE-PORE AND THIN-FILM MODELS OF POROUS GAS DIFFUSION ELECTRODES. L. G. Austin et al., I&EC Fundamentals, Aug. 1965, 4:321-327. illus., diagrs.

Discusses a simple-pore model to illustrate the mode of operation of nonwetted electrodes and a thin-film model for wetted, double-layer structure electrodes.

SIMPLE SYSTEM COOLS FUEL CELL. Chemical Engineering, 2 Aug. 1965, 72:56. illus.

Allis-Chalmers has developed a power supply for unmanned space vehicles. Two features of this power supply are a simplified cooling system which uses thermal radiation, and a static moisture-removal system which vaporizes the water produced during cell operation.

SWEDISH FIRM GROOMS SOME BIG NEW FUEL CELLS. Chemical Engineering, 30 Aug. 1965, 72:58. illus.

Hydrogen-oxygen fuel cells operating at atmospheric pressures and at temperatures about 160^{0}-212^{0}F are being developed and manufactured by a Swedish firm for use on submarines, mining equipment, fork-lift trucks, and similar heavy-traction equipment.

TOWARD AN ARMY WITHOUT GASOLINE. Product Engineering, 15 Feb. 1965, 36:63,64. illus., diagrs.

Fuel cells are being developed which combine two types of fuels. The army hopes to use fuel cells instead of conventional gas-powered vehicles.

WHAT'S NEW WITH FUEL CELLS? Chemical Engineering, 26 Apr. 1965, 72:74.

A high-temperature fuel cell with a cerium oxide electrolyte has been developed in Japan. A new use for fuel cells, remote monitoring of oxygen concentration, has been developed by General Electric and the National Aeronautics and Space Administration.

1966

BORON CARBIDE, A NEW SUBSTRATE FOR FUEL CELL ELECTROCATALYSTS. W. T. Grubb and D. W. McKee, Nature, 9 Apr. 1966, 210:192-194. diagrs. (A66-27902)

Boron carbide as a support for platinum electrocatalysts results in decreased platinum content with no reduction in performance.

COMPARISON OF PLATINUM AND ITS GROUP VIII NEAREST NEIGHBORS AS ANODE ELECTROCATALYSTS IN PROPANE-PHOSPHORIC ACID FUEL CELLS. Journal of the Electrochemical Society, Feb. 1966, 113:191,192. diagrs.

Experimental work was performed to determine the effectiveness of platinum, palladium, rhodium and iridium blocks as electrocatalysts for anodic oxidation of hydrocarbons at 110^{0}-200^{0}C. The data support the conclusion that platinum is the best simple electrocatalyst under these conditions.

CURRENT DISTRIBUTION AT A GAS-ELECTRODE-ELECTROLYTE INTERFACE. 1. Experimental Observations. D. N. Bennion and C. W. Tobias, Journal of the Electrochemical Society, Jun. 1966, 113:589-593. illus., diagrs.

Describes experimental work designed to analyze transport phenomena at gas electrode-electrolyte interfaces, since many fuel-cell fuels and oxidants are gases.

DEVELOPMENTS TO WATCH: ZIRCONIA FUEL CELLS. Product Engineering, 20 Jun. 1966, 37:21.

Newsnote outlining the development of zirconia fuel cells using solid solutions of calcia or yttria in zirconia.

ELECTROCHEMICAL MEASUREMENTS OF THE AVAILABLE SURFACE AREA OF CARBON-SUPPORTED PLATINUM. J. F. Connolly et al., Journal of the Electrochemical Society, Jun. 1966, 113:577-580. diagrs.

Describes experimental work to determine the amount of unavailable platinum in platinized porous-carbon electrodes for fuel cells.

ENERGETICS I: FUEL-CELL SYSTEMS. E. M. Cohn, Mechanical Engineering, Jun.1966, 88:22-27.illus., diagrs.

Discusses the common attributes of fuel cells and describes the GEMINI fuel-cell system. Future applications are listed.

FUEL CELL SYSTEMS AND PROCESSES. CEP Chemical Engineering Progress, May 1966, 62:65-84. illus., diagrs.

A symposium on current progress in fuel cell technology.

FUEL CELL WORKS AFTER 7-MILE FALL. Technology Week, 18 Jul. 1966, 19:19. illus.

Newsnote describing an adverse-condition test of fuel cells.

FUEL CELLS. Missiles & Rockets, 29 Mar. 1966, 16:81. illus.

Reports on research and development efforts in fuel cells at Fort Monmouth. The tactical possibilities of hydrogen-oxygen fuel cells, methanol-air fuel cells, and indirect hydrocarbon combustion for cells are discussed.

FUEL CELLS...WHAT THEY MEAN TO INDUSTRY. Mill & Factory, Jan. 1966 78:70,71. illus.

State-of-the-art of fuel cells for industrial use.

HIGH-PERFORMANCE HYDROCARBON FUEL CELLS WITH FLUORIDE ELECTROLYTES. E. J. Cairns, Nature, 9 Apr. 1966, 210:161,162. (A66-27898)

"Increasing solubility of hydrocarbons in cesium-salt fuel cell electrolyte by replacing some of carbonate anion by fluoride." (Doc. Inc.)

HYDROCARBON-AIR FUEL CELL SYSTEMS. C. G. Peattie, IEEE Spectrum, Jun. 1966, 3:69-76. illus.

A general description of the history, development and possible uses of hydrocarbon-air fuel-cell systems.

LET'S NOT "OVER-SELL" THE FUEL CELL. V. E. Gardner, The Journal of the Electrochemical Society, Jan. 1966, 113:5c.

This editorial discusses some problems which must be solved before large fuel-cell generators can be built.

MOUNTAIN-TOP FUEL CELLS. Electronics, 7 Mar. 1966, 39:301,302. illus.

Newsnote on experiments with West German television relay stations powered by fuel cells.

PERFORMANCE OF OXYGEN FUEL CELL CATHODES CATALYSED WITH BORON CARBIDE. Nature, 23 Apr. 1966, 210:409,410. diagrs. (A66-28174)

Boron carbide catalyst is not as efficient as the precious metal catalysts commonly used. It might, however, be useful as a catalyst support.

POTENTIAL OF A PLATINUM ELECTRODE AT LOW PARTIAL PRESSURES OF HYDROGEN AND OXYGEN II. AN IMPROVED GAS-TIGHT SYSTEM WITH A NEGLIGIBLE OXYGEN LEAK. S. Schuldiner et al., The Journal of the Electrochemical Society, Jun. 1966, 113:573-577. diagrs.

"True steady-state open-circuit potentials can be obtained and maintained when sufficient steps are taken to insure solution, gas purity and electrode cleanliness." (Author)

POWER GENERATION IN SPACE. W. T. Gunston, Science Journal, Feb. 1966, 2:31-37. illus., diagrs.

Discusses and compares various power systems (including fuel cells) suitable for space applications.

PRELIMINARY EVALUATION OF CERIA-LANTHANA AS A SOLID ELECTROLYTE FOR FUEL CELLS. The Journal of the Electrochemical Society, May 1966, 113:502-504. illus., diagrs.

"Change in open-circuit voltage after current is drawn indicates a change in electrolyte composition. Hence, ceria-lanthana solid solution is probably not suitable for use as solid electrolyte in fuel cells." (Author)

REGENERATIVE FUEL CELL ACHIEVES HIGH EFFICIENCY. Machine Design, 6 Jan. 1966, 38:24. diagrs.

Describes a fuel cell with a high energy-to-weight ratio developed by Electro-Optical Systems, Inc.

STUDIES OF HYDROCARBON FUEL CELL ANODES BY THE MULTIPULSE POTENTIODYNAMIC METHOD II. BEHAVIOR OF METHANE ON CONDUCTING POROUS TEFLON ELECTRODES. L. W. Niedrach, The Journal of the Electrochemical Society, Jul. 1966, 113:645-650.

"Rates of adsorption of methane on semimicro Teflon-bonded, platinum black fuel cell electrodes in the presence of a perchloric acid electrolyte are about an order of magnitude lower than those previously observed with ethane." (Author)

THEORY OF THE PERFORMANCE OF POROUS FUEL CELL ELECTRODES. J. A. Rockett and R. Brown, The Journal of the Electrochemical Society, Mar. 1966, 113: 207-213. diagrs.

"A theoretical analysis of the polarization mechanisms in a porous fuel cell electrode was made employing a model consisting of a single pore coated by a thin film of electrolyte. The analysis accounted for those polarizations associated with transport of electrolyte species, transport of dissolved gas, chemical reaction at the solid-liquid interface and ohmic losses in the electrolyte. The theory was compared with data from biporous nickel electrodes operating in oxygen at 80% KOH at temperatures ranging from 300^{0} to 500^{0} F." (Author)

WHEN WILL FUEL CELLS BE READY FOR EVERYDAY USE? Product Engineering, 20 Jun. 1966, 37:77-79. illus., diagrs.

Describes present-day fuel-cell progress and applications. Discusses cost factors, competitive position with batteries, and other problems which affect fuel-cell production and acceptance in industry.

July 1963 to Date

FRONTIERS IN FUEL CELLS. July 1963 to date, Venture-Tech, Inc., St. Louis.

A monthly newsletter which reports recent fuel cell developments, contracts, and patents. Also included are notes, current documents, books, and journal articles in this field.

BOOKS

1960

FUEL CELLS, Vol. I. (Symposium held by the Gas and Fuel Division, American Chemical Society, National Meeting, 136th, Atlantic City, N.J.) G.J. Young, Rheinhold, New York, 1960. 154 p. (TK2920/F953).

Papers on fuel cell technology discuss high and low temperature fuel cells, carbonaceous fuel cells and molten alkali carbonate cells.

1963

ENERGY CONVERSION. S. S. L. Chang, Prentice Hall, Englewood Cliffs, N.J., 1963. 237 p., illus., diagrs. (TK2896/C456).

A chapter entitled "Free Energy and Fuel Cells" discusses the energy conversion process in fuel cells.

FUEL CELL SYSTEMS. (Symposia sponsored by the Division of Fuel Chemistry, American Chemical Society, National Meetings, 145th and 146th, New York, N.Y., Sept. 12-13, 1963, and Philadelphia, Pa., April 6-7, 1964) G. J. Young and H. R. Linden, editors, American Chemical Society, Washington, 1965. (A65-22353; TK2920/A512).

This book is composed of articles on various aspects of fuel-cell research and technology, including an article on NASA's fuel-cell program.

FUEL CELLS. Editors of Chemical Engineering Progress, American Institute of Chemical Engineers, New York, 1963. 95 p., illus., diagrs. (TK2920/C517).

A series of papers on fuel-cell research being conducted by United States and European companies.

FUEL CELLS. W. Mitchell, editor, Academic Press, New York, 1963. 442 p. (TK2920/M682).

This book presents a broad picture of fuel cell development and technology.

FUEL CELLS, Vol. II. (Symposium held by the Division of Fuel Chemistry and Petroleum Chemistry, American Chemical Society, National Meeting, 140th, Chicago,Ill.) G. J. Young, editor, Rheinhold, New York, 1963. 224 p. (TK2920/F953).

This volume reflects the advances in fuel cell technology since the first volume was published. Basic research in fuel cell parameters is reported.

THE FUTURE OF FUEL TECHNOLOGY. (Proceedings of a Conference held by the Institute of Fuel at the invitation and in collaboration with the Royal Institution of Engineers, Amsterdam, Netherlands, May, 1963) G. N. Critchley, editor, Pergamon Press, New York, 1964. illus. (Ref/TP315/I59).

A chapter entitled "Fuel Requirements for Fuel Cells" discusses factors influencing the selection of fuels for fuel-cell development, including cost, availability, and reactivity.

POWER SYSTEMS FOR SPACE FLIGHT. M. A. Zipkin and R. N. Edwards, editors, Academic Press, New York, London, 1963. illus., diagrs. (TL507/P964).

Contains several papers on fuel-cell (especially hydrogen-oxygen fuel cell) technology and applications.

1964

GOLDEN GATE METALS CONFERENCE, San Francisco, 1964. Materials Science and Technology for Advanced Applications, Vol. II. "Today's Problems in the Use of Advanced Materials." (Technical papers, San Francisco, Feb. 13-15, 1964) 1964, 776 p., illus., diagrs. (A64-21704; TA401/G6184).

A paper by D. L. Douglas ("Materials for Fuel Cells") discusses the materials used for components and parts of several of the principal fuel-cell systems under development. (pp. 312-322)

LUNAR MISSIONS AND EXPLORATION. C. T. Leondes and R. W. Vance, editors, John Wiley and Sons, Inc., New York, 1964. 669 p., illus. (A65-13097; TL799.M6/L582).

A chapter on space power systems discusses fuel cells with emphasis on heat-rejection problems.

SPACE POWER SYSTEMS ENGINEERING. G. C. Szego and J. E. Taylor, editors, Academic Press, New York, 1966. 1302 p., illus., diagrs. (Ref/TL507/P964/V.16).

Several papers discuss fuel-cell systems for space applications.

1965

BATTERIES 2: RESEARCH AND DEVELOPMENT IN NON-MECHANICAL ELECTRICAL POWER SOURCES. (Proceedings of the 4th International Symposium, Brighton, September 1964) D. H. Collins, editor, Pergamon Press, Oxford, 1965. 543 p., illus. (Ref/TK2896/161).

Includes several articles on basic fuel-cell research.

CERAMICS FOR ADVANCED TECHNOLOGIES. J. E. Hove and W. C. Riley, editors, John Wiley and Sons, Inc., New York, 1965. diagrs. (TA430/H845).

A chapter on auxiliary power devices discusses fuel cells as well as other power sources.

DIRECT ENERGY CONVERSION. S. W. Angast, Allyn & Baur, Boston, 1965. 431 p., illus., diagrs. (TK2896/A593).

A comprehensive chapter discusses fuel-cell history and design.

ENGINEERING DEVELOPMENTS IN ENERGY CONVERSION. (Presented at International Conference on Energetics, University of Rochester, Aug. 18-20, 1965) American Society of Mechanical Engineers, New York, 1965. 327 p., illus., diagrs. (A66-18308; Ref/TK2896/I61e).

Includes a section entitled "Fuel Cells for Power Generation".

HYDROCARBON FUEL CELL TECHNOLOGY. (Symposium organized by the Division of Fuel Chemistry, American Chemical Society, National Meeting, 150th, Atlantic City, N.J.) B. S. Baker, editor, Academic Press, New York, 1965. 560 p., illus., diagrs. (Ref/TK2931/B167).

Among the types of fuel cells discussed are hydrogen-oxygen, hydrocarbon-air, carbon-air, natural gas-acid, alcohol-air, formation-oxygen, methanol, and molten carbonate.

PROCEEDINGS OF THE FIRST AUSTRALIAN CONFERENCE ON ELECTROCHEMISTRY HELD IN SYDNEY, 13-15th FEBRUARY, AND HOBARD, 18-20th FEBRUARY 1963. Pergamon Press, New York, 1965. 954 p., illus., diagrs. (Ref/QD552/A938; A65-32164).

Includes a section on the electrokinetics of fuel cells.

PROCEEDINGS XIVth INTERNATIONAL ASTRONAUTICAL CONGRESS, PARIS, 1963, VOL. I. Gauthier-Villars, Paris, 1965. diagrs. (Ref/TL787/I61p).

A chapter entitled "Application Spatiale des Piles a Combustible" discusses high temperature fuel cells, especially membrane cells, and their space applications. This chapter is in French.

1966

AEROSPACE LIFE SUPPORT. (Chemical Engineering Progress Symposium Series, Vol. 62, No. 63, 1966) L. Elikan, editor, American Institute of Chemical Engineers, New York, 1966. 99 p., illus., diagrs. (Ref/TL1500/E42)

Contains papers on the role of fuel cells in life-support systems.

FUEL CELLS. An Introduction to Electrochemistry. H. A. Klein, Lippincott, Philadelphia, 1966. 148 p., illus., diagrs. (TK2931/K64).

No abstract.

FUEL CELLS, THEIR ELECTROCHEMICAL KINETICS. V. S. Bogotskii and Y. B. Vasil'ev, editors, Consultants Bureau, New York, 1966. 121 p., diagrs. (A66-25667; TK2920/B148).

A collection of articles on the theory of fuel cells presented at the Second Fuel Cell Conference in Moscow. Several articles discuss porous electrodes. Developments in the field of electrochemical oxidation of organic materials are also presented.

AN INTRODUCTION TO FUEL CELLS. K. R. Williams, editor, Elsevier, Amsterdam, New York, 1966. 329 p., illus. (A66-18467; TK2931/W724).

A basic work on fuel cells, which surveys all aspects of their technology and development.